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A STUDY ON THE EMERGING PACKAGING TECHNOLOGIES–ON THE BASIS OF THE PACKING TECHNIQUE'S CURRENT SITUATION AND SMART PACKAGING DEVELOPMENT

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ABSTRACT

Background/Objectives

Nowadays, a protective packaging such as active packaging, various packaging techniques beyond simple packaging are emerging. Ultimately the smart packaging technique has be emerged based on new packaging techniques.

Methods/Statistical Analysis

The purpose of this study is to look into the history of past packaging and the present packaging techniques. And this study is going to suggest the future development method of the smart packaging based on the research of the past and present packaging techniques.

Findings

The most basic function of packaging is to protect a product. In case of smart packaging, there's a one more meaning that is indicating. In other words, smart packaging is a product protection by indicating status of food or something in packaging material. Some packaging methods have been often seen around us. Smart packaging is surely best available technology but it causes rise in packaging cost. Also, some electronic tag and RFID have problems such as regulations especially between countries and personal privacy. Packaging is really closed to our lives and its trends are always changing due to our life style. Meanwhile, packaging is constantly evolving. *Domestic packaging industry has been growing fast enough to not even compare favorably with developed countries. However, the situation in the domestic packaging market is still following the developed countries' techniques. Many companies which are related with packaging industries in Korea are small. Neither a foreign country. But advanced countries have really powerful association and they have many educational programs and always do focus to find new packaging market to introduce to their local* ***practicians*** *and consumers. We need to benchmark and try to promote our technique widly.*

Improvements/Applications

We need to focus on a national promotion of packaging technology. Consumer doesn't know and why they need it. It requires a creation of demand through an active promotion.

KEYWORDS: Packaging (Packing), Vacuum Packaging, Gas Flushing Packaging, MAP(Modified Atmosphere Packaging), Smart Packaging, Active Packaging & Intelligent Packaging

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Original Article

INTRODUCTION

Packaging has close relationship with our daily life in modern society and is considered as one of the most important industries, which can be found easily and one of the protective materials of a product. Consecutive traditional packaging evolvement brought in the smart packaging in 21st century, which is new developing packing field.

In Korea, Packaging is described as the means of packing method and packing condition to protect a product value and product condition with appropriate material or container etc. in the product distribution process [1]. As above description shows that protecting a product is one of the main functions of the packaging.

We may find that the packaging form is divided in various types. The most common packaging type is the groceries packaging. Packaging is used widely in other industries too apart from the groceries and numerous packaging techniques exist based on a product nature and shape.

As we enter 21st century various packaging techniques are being evolved and developed and one of the emerging packing technologies is the smart packaging.

Smart Packaging can be described as the packaging technique, which monitors external and internal environment of packaging such as temperature, pH, pressure, light etc. or protects the product through adapting to environment[2]. Some call it as Intelligent Packaging technique.

This research looks into the past packaging technique along with the present packaging technique and suggests the future development direction of the smart packaging.

PACKAGING DESCRIPTION AND HISTORY

Packaging History

Pre-Renaissance Packaging

It is known by archaeologists that the packaging was used for ceramics packing and protection in China in the 3,000 B.C. and records show that packaging was used as cosmetics container in ancient Egypt. Besides, packaging technique can be found in the mummy case, which was discovered in the tomb of pharaoh Tutankhaman, that was mummy case protective unique packaging technique containing wood and a stone coffin along with gold. Records show that an amphora, which was called as ‘Canaanite Jar’ was used as a container for wine, oil and other liquid in 1800 B.C. Also, a glass container was discovered in Egypt and Mesopotamia in 1500 B.C. On the other hand, the Greeks, under consideration of packaging and transportation, used earthen pot as wine container in Greco-Persian war period to import wine from Phoenicia to Egypt. And every castellan of Egypt gathered all earthen pots, which came from Phoenicia, filled them with water and sends the earthen pots to desert in 530 B.C. Eventually it became the origin of container reuse in modern time. Right before Century, a leather materials evolved as easy broken earthen pots caused some diseases. Glass bottles were already being used as an ointment pot before A.D 79. People’s name was written on the cap’s knob, and it became the origin of branded packaging. Apart from above mentioned packaging methods, other packaging methods such as a bamboo trunk paper techniques of China and Southeastern Asia, existed.

The Renaissance and the Industrial Revolution and Modern Time

Packaging was considered as simple thing as and packaging technique study was considered as worthless study in the pre-renaissance period. The packaging technique development was started emerging throughout the Renaissance and

the industrial revolution period. The supplies distribution revolution such as mass production, mass distribution, mass consumption of post 18th century industrial revolution had massive impact on the packaging industry. Through that process, packaging became a part of a product and it impacted on product storage and distribution process. By present time, the main goal of the packaging was to protect a product.

In 20th century packaging industry kept developing in several methods and its technology also kept fast growing development. Emerging 'plastic material' terminology made new invention and innovation possible as new packaging material.

The packaging techniques, which set importance on the packing functionality, are emerging in 21st century. And one of the emerging packaging techniques is the smart packaging.

PACKAGING TECHNIQUE

Packaging classification can be variously divided depending on packaging use purpose. Packaging classification can be divided based on packaging nature and packaging contents. 'Introduction to packaging', which was published by Packaging industry Co., Ltd, indicates 24 packaging techniques. This section specifies the smart packaging based on general packaging technique division and the smart packaging related packing techniques.

Vacuum Packaging

The purpose of the vacuum packaging is to prevent goods deterioration through inhaling and exhausting air from seal packing, using packaging material, which composes of excellent gas barrier property. Vacuum packaging is preceded in vacuum and decompressing sealing packaging method. In other words, removing air from a container or plastic bag after putting a product into the container or plastic bag is called vacuum packaging technique. It is common to use the vacuum packaging for groceries packing.

The purpose of the vacuum packaging is to increase expiration period of groceries through groceries spoilage prevention and to prevent from oxidation corrosion of an industrial product. Generally, the groceries vacuum packaging helps to extend groceries expiration period through decreasing absolute concentration of oxygen and interrupting mold and aerobic microbe's growth and oxidation block. The vacuum packaging of the industrial product blocks the product oxidation through removing oxygen and protects the product from dust and humidity[3]. <Insert figure 1.>

Figure 1: Nozzle Type and Chamber Type Vacuum Sealer

Gas Flushing Packaging

In simple words, Gas Flushing Packaging is the technique which injects gas into packing bag or container and is called MAP (Modified Atmosphere Packaging) as well.

MAP technique extends expiration period of groceries and injects mixture gas into groceries or general goods packing material. Gas ratio can be different based on contents nature and generally, O_2, CO_2 and N_2 are used[4]. MAP

technique has been used for meat packing so far.

Modified Atmosphere Packaging is an optimal blend of pure oxygen, carbon dioxide and nitrogen within a high barrier or permeable package. A finely adjusted and carefully controlled gas blend is developed to meet the specific respiration needs for each packaged food product. Plastic films, foils and other packaging materials that demonstrate specified gas permeability properties and/or water vapour permeability properties are selected for use. These high barrier substrates become MAP Packages after they are formed into trays, lid stock or bags and filled with a select blend of oxygen, carbon dioxide and nitrogen environmental gasses. Packaging films are selected to match the characteristics and needs of the food product. Film permeability, water vapour transmission rates and sealing characteristics need to be measured and tested at film selection and again at package converting and product fill stages, since the ability of a film to handle MAP performance characteristics may vary within each stage. <Insert figure 2.>

Figure 2: MAP Packaging Machine

Active Packaging

Active Packaging technique is used in the purpose of groceries (meat) quality maintenance and extending expiration period of groceries (meat) through putting packaging system additive[5]. Additives include contents deterioration protective materials such as deoxidizer, gas absorbent, silica gel etc. and some additives include more materials apart from above materials. Additives are usually used for groceries packaging.

Active packaging technique applies above mentioned vacuum, MAP method, and deoxidizer or other additives to packing and helps keeping products for longer period or protecting them from spoilage.

In the case of some groceries, we can see ‘Do not eat’ mark along with a tiny absorbent on the other contents except for original package contents. The tiny absorbent includes deoxidizer. A dehumidifying material-silica gel is one of the most common absorbents.

Those absorbents were developed in Japain in 1970s. Deoxidizer is used for rust prevention or oxidation of metal compound, which composed of oxygen and water[6].

Deoxidizer is put in package to prevent oxygen as the oxygen is the main cause of food spoilage. The reason is that complete vacuum supply in the vacuum packaging is difficult and packing is proceeded attaching deoxidizer to complement limitation due to packing material penetration problem. The deoxidizer basically maintain below 0.1% oxygen concentration in package[7]. <Insert figure 3.>

Figure 3: Various Additives for the Active Packaging

Smart Packaging and Intelligent Packaging

Intelligent packaging is the type of packaging system, which is defined as the system for products stability and quality improvement in groceries storage and distribution process through detecting and recording of a groceries change inside package[8]. In other words, it is packaging technique to examine groceries of inside package.

Some call the intelligent packaging as the smart packaging. According to Professor Yam of Rutgers the state university of New Jersey, both terminologies, the intelligent packaging and smart packaging are mixed and clear definition on those two techniques has not been made yet[9].

Intelligent packaging includes various type and function. As shown in table 1, it shows the type and function of the intelligent packaging. <Insert table 1.>

Table 1: Intelligent Packaging Type and Function

Type	Function
TTI(Time Temperature Integrating indicator)	Groceries quality detection
Bar Code	Tracking, Logistics
EAS tag (Electronic Article Surveillance)	Anti-theft function
EMID tag (Electromagnetic Identification)	Anti-theft function, brand protection, tracking and logistics
Digital Watermark	Brand protection and falsification prevention
Leading indicator	Groceries quality detection
RFID tag (Radio Frequency Identification)	Information delivery, logistics, tracking

<Functionality and Intelligent packaging, Lee Dong Son, 2006>

TTI is the form of label and is attached onto surface of package or is included in package itself. It shows changing status of the product as color change based on temperature change in storage, distribution process. TTI indicates warning sign in the case of improper control of important frozen food on behalf of simple expiration date of the goods[10]. Once TTI used in a beer company to maintain appropriate temperature for drinking a beer by indicating color change.

The important function of TTI is to advise a consumer to intuitively judge on package status or inside status of package. This function cannot be controled by outside and is able to indicate the package status intelligently or in smart way to related consumer.

RFID tag is also used for several purposes.

RFID stands for Radio Frequency Identification and is also called as 'Electronic tag' which is the system to

distinguish ID using frequency. Above RFID definition can be interpreted in two meanings based on visual difference. The first is the RFID tag included object intellectualization and the second one is RFID defining perspective in Ubiquitous-sensor network service point, deciding possible value in the point of RFID effect in designated field through RFID tag included objects network[11].

RFID is widely used in not only packaging industry but also manufacture and distribution along with service fields. RFID in packaging industry is used for groceries medicine package and is used from those goods manufacture process to distribution, sales control. And also it is used for identifying goods' forgery, falsification and genuine goods. RFID is also used for anti-theft purpose, expiration period offer for consumers' stability securement and necessary information supply. <Insert figure 4.>

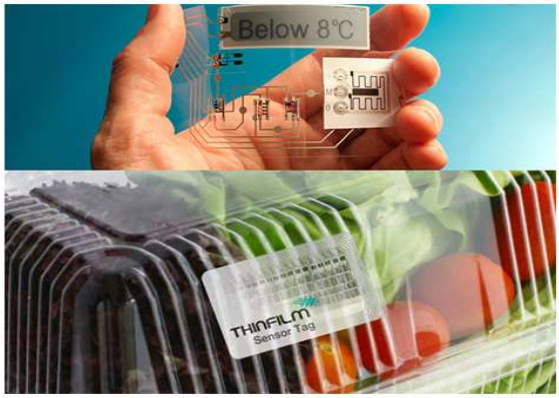

Figure 4: Example-Intelligent Packaging

THE CURRENT STATUS AND PROBLEM OF SMART PACKAGING (INTELLIGENT PACKAGING) AND ITS FURTHER DEVELOPMENT DIRECTION

The Current Status and Problem of Smart Packaging

The Current Status of Smart Packaging

The smart packaging (intelligent packaging) has already become one part of our daily life and is taking center stage as new technique in the packaging industry in 21st century.

Frost & Sullivan stated in 'Impact Assessment of Smart Packaging in Healthcare, Electronics, and Energy' report that the smart packaging achieved one of the greatest development in modern health care and electronic product industry [12].

As 3.4 section shows that various smart packaging (intelligent packaging) techniques exist and are applied to not only groceries but also electronic product, health care related items as well.

In the case of RFID, it was originally used in logistics industry and now new terminology-'RFID packaging' has been made thanks to packaging and RFID combination. CJ GLS has published "RFID smart packaging guideline" in autumn symposium journal of Korean Institute of Industrial Engineers. The paper suggested 'RFID smart packaging guideline' applying RFID to initial unit packaging and final packaging[13]. It was the smart convergence attempt, which converges not only packaging but also logistics industry.

Current Problem of Smart Packaging

One of the basic elements of packaging is a product protection. Protection may have broad meaning but protection means not only contents protection of inside packaging but also examining the package condition at the same time in the

smart packaging field. But the problem is that even though basic protection is required for a product package, it refined design of package and additional packaging elements may cause higher cost.

In the case of TTI, it is widely used in foreign countries, yet it is still hard to find TTI in South Korea. Leading indicator was patent registered under 'Freshness Indicator for Fresh Produce and Manufacturing Method Thereof' state of Korea Food Research Institute. However it is still hard to find those two in local market for unknown reason. Those problems suggest that there are still some tasks left to solve in technological and cost aspect for using smart packaging commercially.

Even though EAS, EMID and RFID can be found easily, those also have cost problem. Even if cost problem is reduced thanks to technological development, unfortunately technological development is still applied to limited fields only. The reason may be due to problems which are caused by regulations among countries and invasion of privacy problem of RFID is also the task to resolve.

Further Development Direction of Smart Packaging

We have looked through some packaging techniques and smart packaging definition along with current status of smart packaging and its problems.

First of all cost shall be considered as the main solution to apply smart packaging technique to packaging based on practical technology development. Cost aspect can be naturally solved as time goes by and smart packaging is popularized. However, more important thing is how to popularize the smart packaging. The cost problem can be solved once the smart packaging gets pop In this case consumer's awareness of the smart packaging plays very important role. Once the product, which has cost-effectiveness and good technology cannot be recognized and ignored by consumers, cannot be successful. The beef background tracking system has been introduced and still bein promoted to Korea, which enables consumers to track their consuming beef information by their smart phones. However there is still no statistical information on how many consumers use the system. And people, who use the system, can be seen in supermarkets or in butcher shop. In other words, the product promotion itself is not enough to win consumers awareness of the product but it is required to build the environment, where consumers may use and access to the product easily.

Despite of frequent use of technologies such as RFID and anti-thief tag, some still cannot recognize that technology's importance and some ethical problems are posed due to those technologies use. The solution for those problems can be found through national and citizen along with government aspect. Besides, active methods shall be found on the product reuse. The anti-thief tag reuse is very common in supermarkets. However the product reuse of inside package can be impossible in product release process. Eventually all those problems are caused at consumers' expense. Above problems shall also be resolved by standard regulations or institutionalization.

CONCLUSIONS

Packaging (packing) industry has close relationship with our daily life and is changing and developing as trend and modern life pattern are changing. The packaging industry of Korea has achieved fast growth and is compatible with packaging industries of developed countries. Packaging market of Korea is not small and is equal to 33.4trillion wonas 2011 standard. Packaging market growth of Korea has surpassed average world packaging market two times and is still keeping fast market growth[14]. However local packaging market trend still lag behind developed countries. Korea is still applying not only Japan but also America or Europe's packaging techniques to local market. If the smart packaging of

Korean packaging industry can have capacity to solve 4.1 stated problems and enables to lead market trend, the packaging industry of Korea conquer not only local market but also developed country's market and developing country's market, which have huge development potential and is can be the industry, which can promote itself to the world as one of the representative industries of Korea.

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